



PEPSI User's manual

Issue	1.1
Date	October 23, 2020



Contents

1	Revision History	1
2	About this document	2
3	General information	3
4	Planning the observations	4
4.1	Spectral ranges	4
4.2	Resolution modes	5
4.3	Exposure times	5
5	Executing the observations	6
5.1	Accessing PEPSI Graphical User Interface (GUI)	6
5.2	Connecting with PFU	7
5.3	Selecting and sending targets to LBT	9
5.4	Guiding	12
5.5	Observing	13
5.6	Calibration frames	13
6	Raw data	15
6.1	Viewing obtained spectra	15
6.2	Estimating signal-to-noise ratio	16
7	Telemetry	17
8	Troubleshooting	19



1 Revision History

Table 1: Revision history

Issue	Date	Changes	Responsible
1.0	13.01.2020	First version	S. Järvinen
1.1	23.10.2020	Changed facility status and login information	S. Järvinen



2 About this document

This document describes the design details of the PEPSI spectrograph that are relevant for planning the observations. It also describes in detail how the observations are performed.



3 General information

PEPSI had PI instrument status at the LBT until 2020A. If you wish to observe with PEPSI and have questions beyond the usual, please contact either the PI Prof. Dr. Klaus G. Strassmeier at AIP or Mark Wagner at LBTO. PEPSI is operated as a facility instrument since Feb. 1, 2020.

The basic description of PEPSI is given by Strassmeier et al. (2015, AN, 336, 324) and (2018, SPIE, 10702, 12).

4 Planning the observations

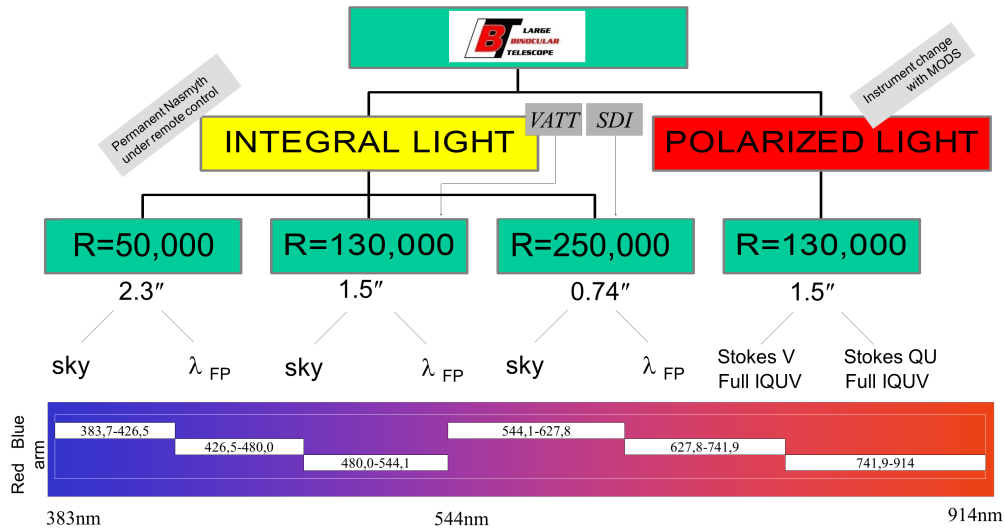


Figure 1: PEPSI observation modes.

4.1 Spectral ranges

The entire spectral range of the PEPSI is from 383 to 912 nm but it **can not** be covered by a single exposure (see, Fig.1 for more details). PEPSI has two arms, blue and red, that cover spectral ranges 383-544 nm and 544-912 nm, respectively. Each arm has three cross-dispersers:

- CD1 383-426 nm in blue arm
- CD2 426-480 nm in blue arm
- CD3 480-544 nm in blue arm
- CD4 544-627 nm in red arm
- CD5 627-741 nm in red arm
- CD6 741-912 nm in red arm

Simultaneously, one can observe one wavelength region in blue and one in red, however, **CDs 3 and 4 can not be used at the same time.**



4.2 Resolution modes

Observations can be done using three different fibers, that is with three different resolutions:

- 100 μm gives $R=250,000$
- 200 μm gives $R=130,000$
- 300 μm gives $R=50,000$

4.3 Exposure times

Exposure time depends on the target, the wanted resolution, and used cross-disperser. Exposure times can be estimated using the exposure time calculator that is available on PEPSI web page.

One can have different exposure times and numbers of exposures for cross-dispersers in blue and in red arm (examples below):

- 30 min in blue, 20 min in red \Leftarrow red is idle for 10 minutes
- 30 min in blue, 2×15 min in red \Leftarrow both are ready around the same time
- 3×10 min in blue, 6×5 min in red \Leftarrow both are ready around the same time, blue likely idle for some minutes due to read-out times (80 sec / read-out)

5 Executing the observations

5.1 Accessing PEPSI Graphical User Interface (GUI)

Observations can be executed either using the PEPSI 4K monitors in the LBT control room or one can observe remotely.

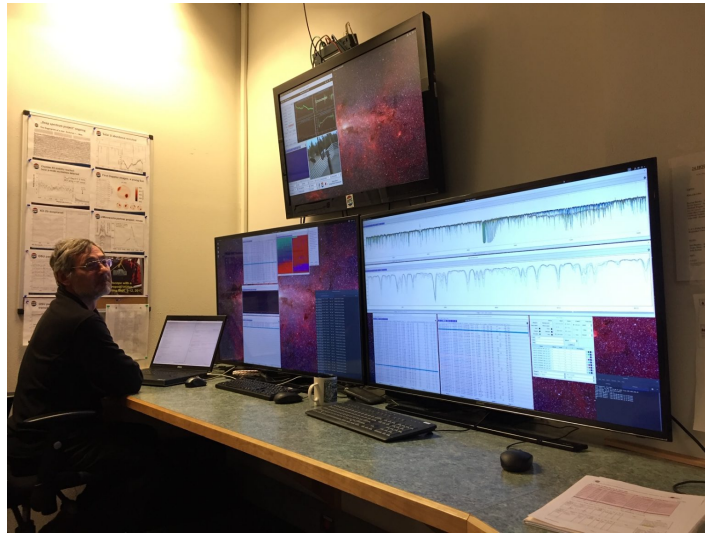


Figure 2: PEPSI computer screens at LBT control room.

In case of remote observing (**NOTE** that you must request SSH and VPN access to LBTO beforehand via this form: [Google Form](#)) from Linux machine

- take **VNC** connection by typing in terminal **vncviewer -via USERNAME@ssh.lbto.org -shared 192.168.164.14:**
- environment (telemetry, see Sect. 7) status can be seen at 192.168.164.14:2
- passwd is given on need to know basis
- in the end, close the connection from the upper corner 'x'

from Mac

- one has to first make a **VPN** connection [vpn.lbto.org](#)
- username and passwd are given on need to know basis
- and then take a VNC (with TigerVNCViewer) connection to server [alpha.pepsi.lbto.org:1](#) (or :2)
- in the end, close the connection with **Fn+F8**, exit viewer and disconnect VPN

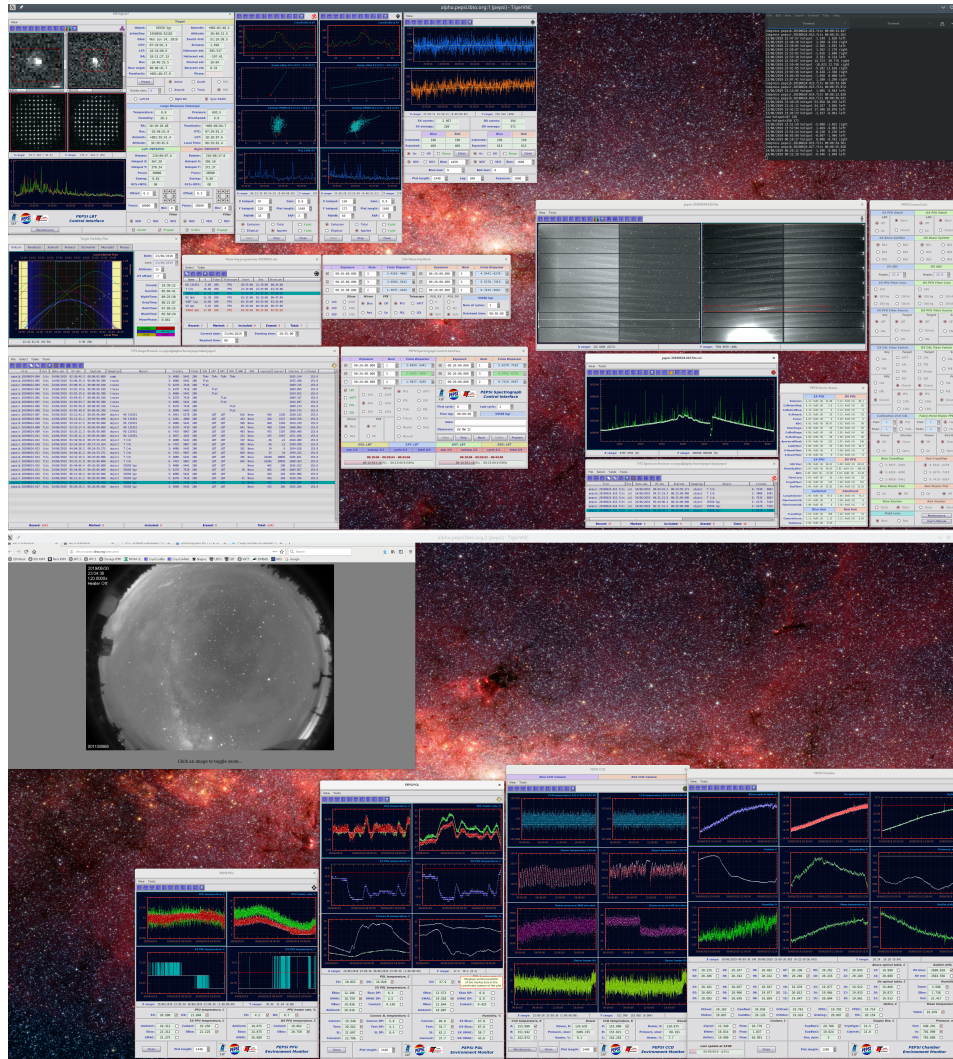


Figure 3: *Top*: VNC view of the user interface (:1). *Bottom*: VNC view of the telemetry (:2).

The PEPSI user interface program should be kept running all the time.

If it is not running, click Activities in the left upper corner. You should get a menu having PEPSI logo. Click on that logo to open the program. Alternatively one can use a terminal to open it (if no terminals open, open a new one). On `pepsi@alpha` type 'pepsi'.

5.2 Connecting with PFU

1. Now you should have 'PEPSI Spectrograph Control Interface' open.
 - In case PEPSI has been used for solar observations (SDI selected) and you have text 'Waiting for Sun' in the 'PEPSI Spectrograph Control Interface', click 'Abort' to be able to start night observations.

The screenshot shows the 'PEPSI Spectrograph Control Interface' window. It contains several sections for configuring observations:

- Exposure Table:** A table with columns 'Exposure', 'Num', and 'Cross Disperser'. It lists three exposures with durations of 00:26:00.000 and various cross disperser ranges.
- Instrument Configuration:** Includes checkboxes for 'LBT', 'VATT', 'POL', and 'SDI'. Radio buttons for 'Slicer' (100, 200P, 200, 100L, 300, 130L) and 'Mirror' (Blue, Red, Off, On). There are also radio buttons for 'PFU', 'VATT', 'POL', 'SDI', 'ThAr', 'FPE', 'Traces', 'Flat', 'Master', 'Dark', and 'Manual'.
- Observation Parameters:** Fields for 'First cycle' (0), 'Last cycle' (1), 'Time lag' (00:00:00), and 'V5558 Sgr'.
- Observers:** A text field containing 'CW MW II'.
- Buttons:** 'Start', 'Stop', 'Abort', 'Calibs', and 'Program'.
- Summary Tables:** Two tables at the bottom showing 'SXS: LBT' and 'DXT: LBT' with columns for 'exp 1/3', 'subexp 1/1', 'cycle 1/1', and 'total 2/4'. They display time ranges and percentages.

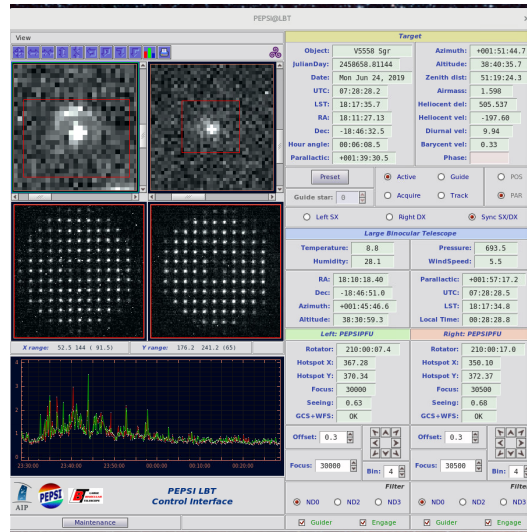
- Click on LBT check button to connect and open 'PEPSI@LBT':

This screenshot is identical to the previous one, but the 'LBT' checkbox in the 'Instrument Configuration' section is highlighted with a red circle, indicating it should be checked.

- Check that PFU radio button is selected:

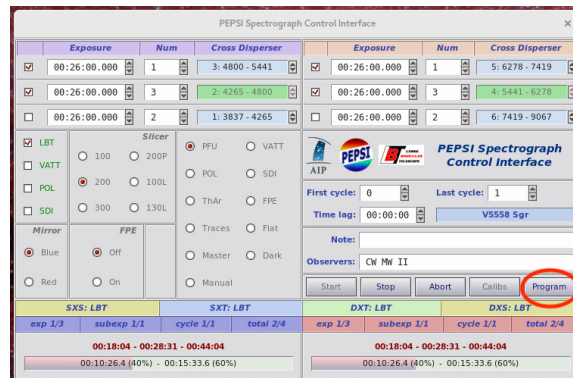
This screenshot is identical to the previous one, but both the 'LBT' checkbox and the 'PFU' radio button in the 'Instrument Configuration' section are highlighted with red circles, indicating they should be selected.

2. A 'PEPSI@LBT' window should appear:

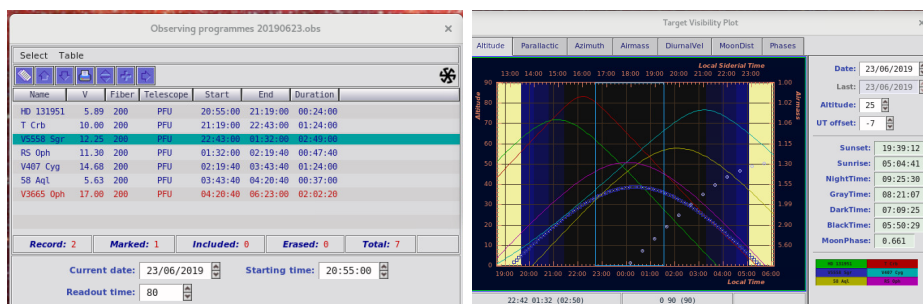


5.3 Selecting and sending targets to LBT

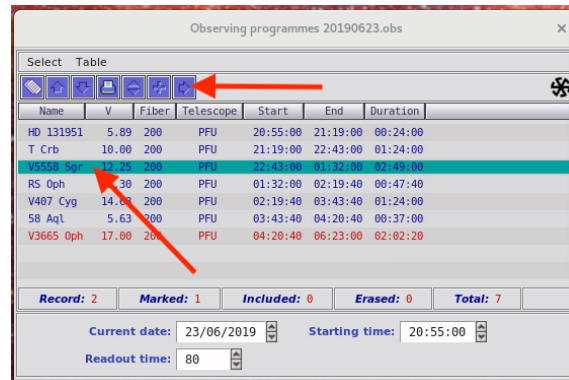
1. Click 'Program' button on 'PEPSI Spectrograph Control Interface':



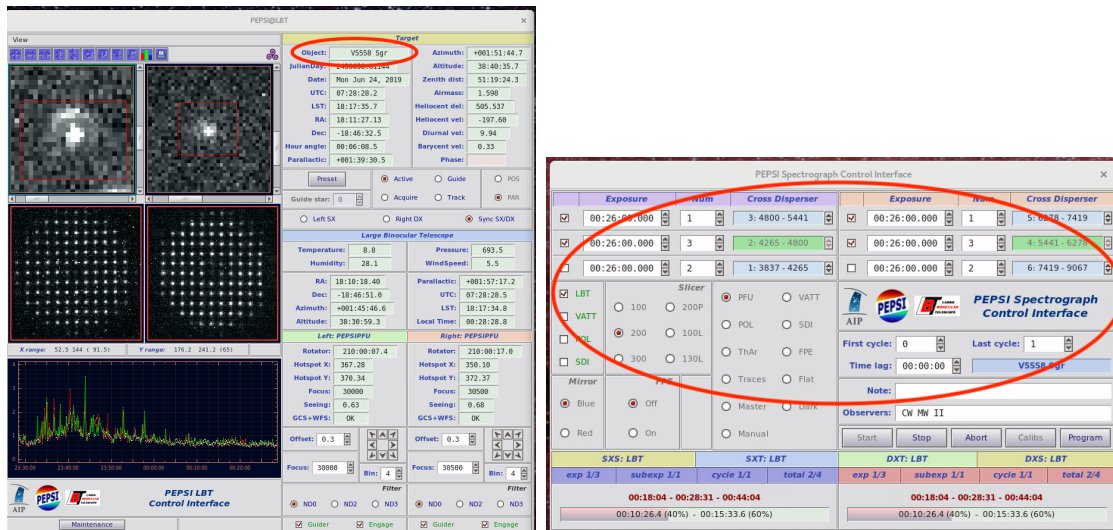
2. When you
 - a) already have an observing program, a 'Observing Programmes' window opens. If not, go to 'Table' menu, choose 'Open or Close Table' and select the correct one.



- If GUI had to be restarted, check that the correct program is open (YYYYMMDD.obs)!
- **select the target** (highlighted with teal color) you want to observe and send it to LBT. This does not yet move the telescope! Note that target can be sent already during CCD readout!

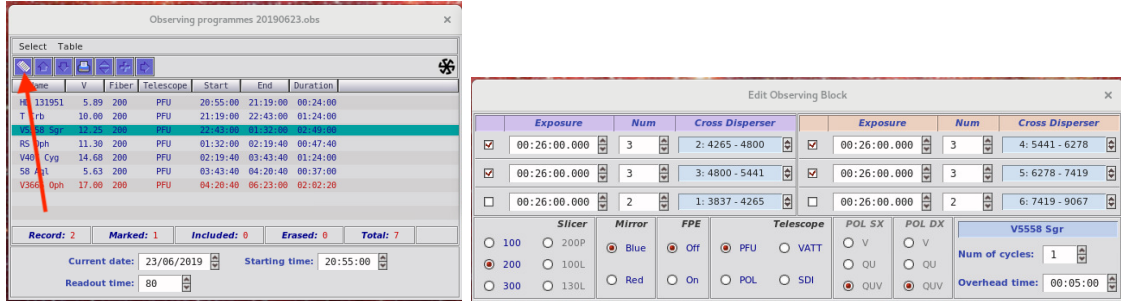


- check that 'PEPSI@LBT' has the same target as you chose, or resend, and check that 'PEPSI Spectrograph Control Interface' changed (target name, selected cross-dispersers, exposure time, etc.) according to selected target. Note that the changes happen only after CCD readout has finished.



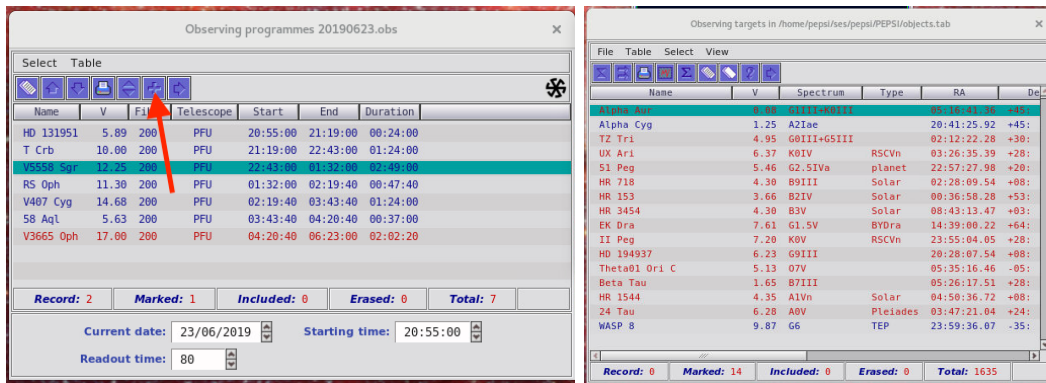
- if you need to change pre-defined exposure times, click 'Edit fields' and a new window pops up and you can make the changes. Note that values in 'PEPSI Spectrograph Control Interface' do not change unless you send the target information again (see A.) You can also change values in 'PEPSI Spectrograph Control Interface' directly, but then the visibility

plot does not change and block will not remember the changes made in future.

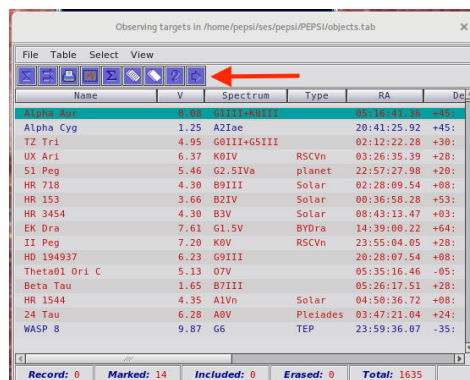


b) don't have any targets or you want to change targets

- See Section 4 for additional information!
- click 'add another object' in 'Observing programmes' window and a new window having targets pops up

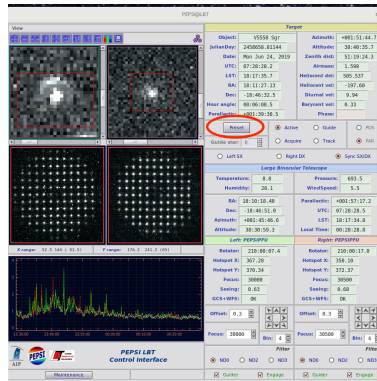


- choose the target and send it to the observing block



- continue as in 2-a.

3. after the telescope operator gives the permission, click 'PRESET'

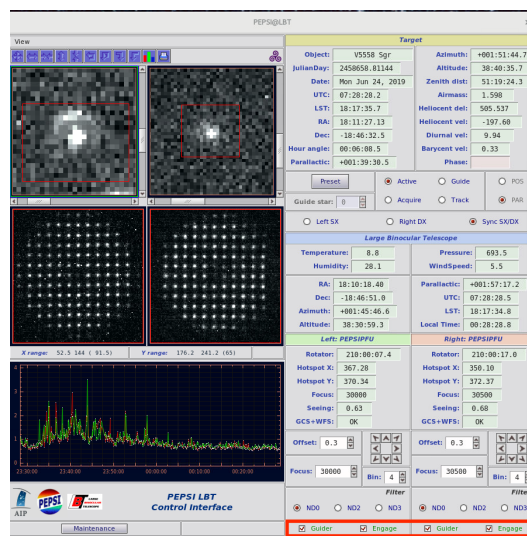


- ‘PRESET’ to next target can be done already during CCD readout.
- Note that ‘Preset’ can be done in four different modes, but only the first one should be used unless requested otherwise by the telescope operator:
 - **Active** – the normal mode, uses wavefront sensor and guiding
 - Guide – no wavefront sensor is used, guiding yes
 - Acquire – only points and centres on hot spot
 - Track – only points

5.4 Guiding

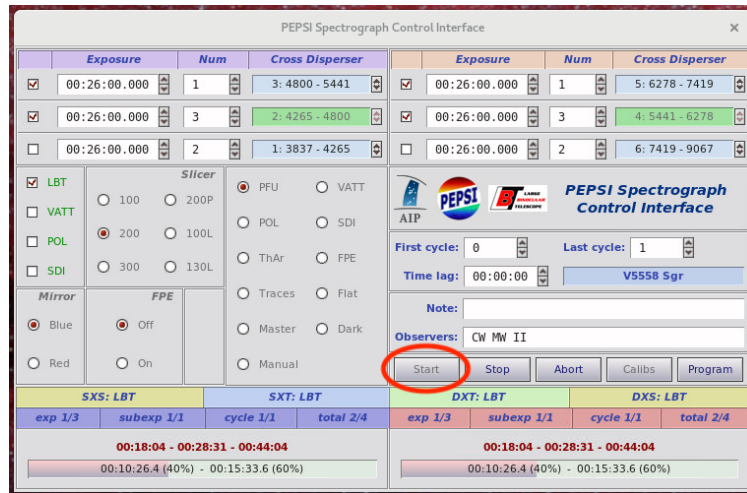
Guiding (and also focusing) is done by the telescope operator. **Do not do anything unless asked.**

- ‘Engage’ opens the hatches so that the telescope operator can put the star in the position.



5.5 Observing

Start observations by clicking ‘Start’ in ‘PEPSI Spectrograph Control Interface’:



If the exposure needs to be interrupted for any reason, use

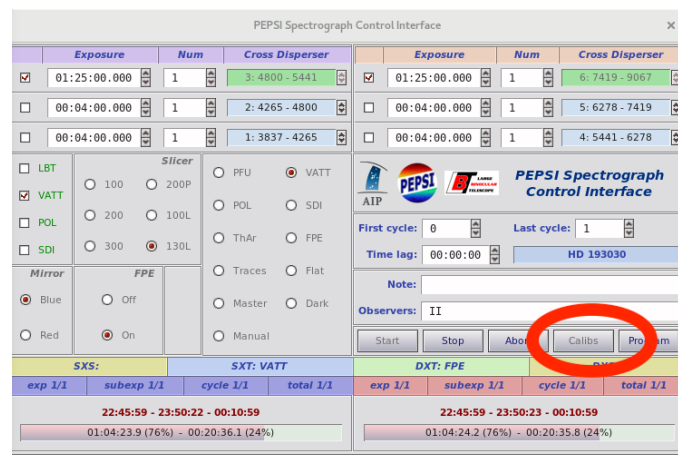
- ‘Stop’ in case you want to save the data obtained so far
- ‘Abort’ in case the exposure time was not long enough for useful data

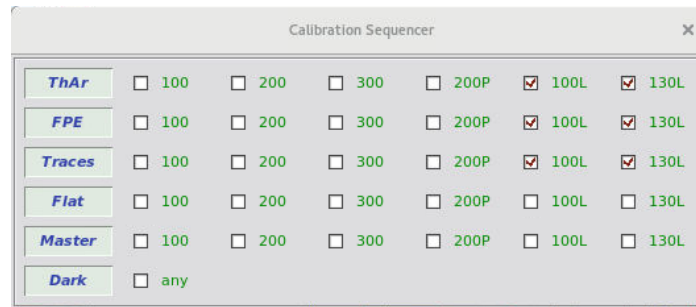
5.6 Calibration frames

After the observing night is over, it is time to take the calibration frames. Check that you have stopped guiding and guider camera is on pause.

In the ‘PEPSI Spectrograph Control Interface’ window:

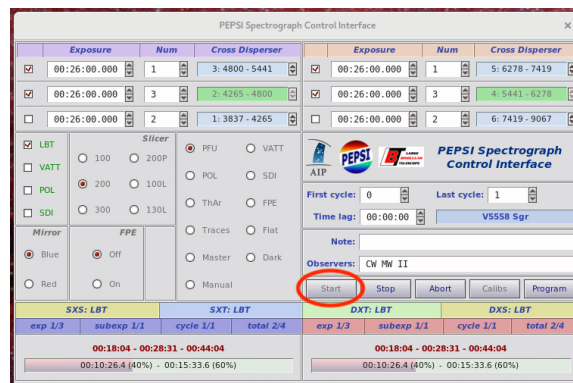
1. Click ‘Calibs’ button to get a pop-up window:





	100	200	300	200P	100L	130L
ThAr	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
FPE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Traces	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Flat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Master	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dark	<input type="checkbox"/>	any				

2. Check that for wanted fiber(s) ThAr, FPE, and Traces are chosen
3. Click 'START' button on Control Interface window:



PEPSI Spectrograph Control Interface

Exposure	Num	Cross Disperser	Exposure	Num	Cross Disperser
00:26:00.000	1	3: 4800 - 5441	00:26:00.000	1	5: 6278 - 7419
00:26:00.000	3	2: 4265 - 4800	00:26:00.000	3	4: 5441 - 6278
00:26:00.000	2	1: 3837 - 4265	00:26:00.000	2	6: 7419 - 9067

☒ LBT ☐ VATT ☐ POL ☐ SDI
☐ 100 ☐ 200P ☐ 200 ☐ 100L ☐ 300 ☐ 130L
☒ Blue ☐ Red ☐ On ☐ Off
☐ PFU ☐ VATT ☐ POL ☐ SDI
☐ ThAr ☐ FPE ☐ Traces ☐ Flat
☐ Master ☐ Dark ☐ Manual

First cycle: 0 Last cycle: 1
 Time lag: 00:00:00 V5558 Sgr
 Note:
 Observers: CW MM II
 Start Stop Abort Calibs Program

SXS: LBT exp 1/3 subexp 1/1 cycle 1/1 total 2/4 00:18:04 - 00:28:31 - 00:44:04
 00:10:26.4 (40%) - 00:15:33.6 (60%)

DXT: LBT exp 1/3 subexp 1/1 cycle 1/1 total 2/4 00:18:04 - 00:28:31 - 00:44:04
 00:10:26.4 (40%) - 00:15:33.6 (60%)

DXS: LBT exp 1/3 subexp 1/1 cycle 1/1 total 2/4 00:18:04 - 00:28:31 - 00:44:04
 00:10:26.4 (40%) - 00:15:33.6 (60%)

4. When calibration frames are ready, click 'Calibs' again to close the calibration sequencer window and to be able to do anything else.

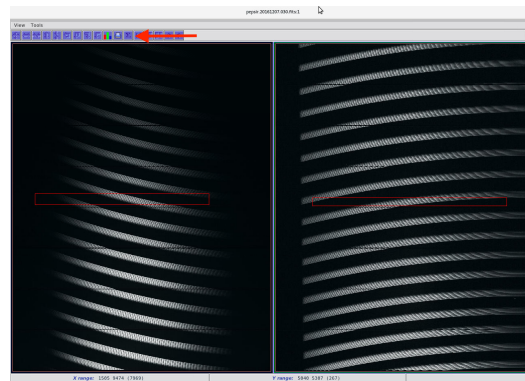
6 Raw data

6.1 Viewing obtained spectra

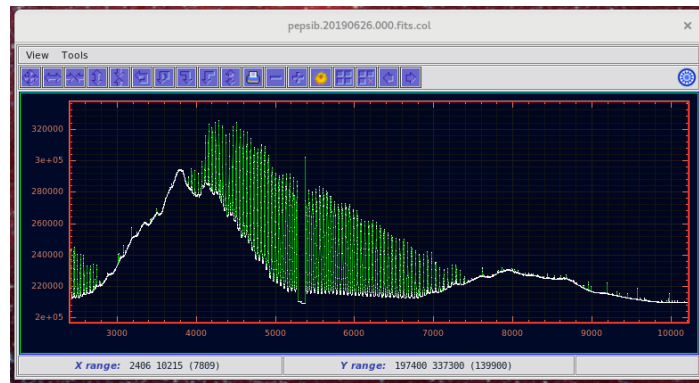
It is good to take a look at the spectra in order to see if you should change exposure times etc.

1. Select the spectrum (highlighted with teal colour) you want to look at from ‘FITS Image Browser’ with Enter or click the arrow icon to send it to ‘Spectrum viewer’. One can also look at multiple spectra by selecting them and clicking double arrow icon.

2. The active window in ‘Spectrum viewer’ has a cyan frame. Select the area you want to look at closer by drawing a red box with, for example, a mouse. To see a summed spectrum from selected area Press ‘Enter’, or Click the normal ‘Sigma’ icon (one dimensional cross-cut in horizontal direction) on top of the viewer (the other sigma makes it in vertical direction)

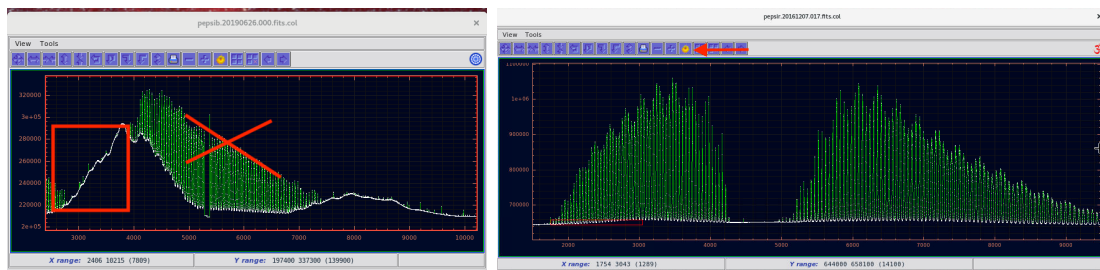


3. Now you have a spectrum plot where you can see the ADUs:

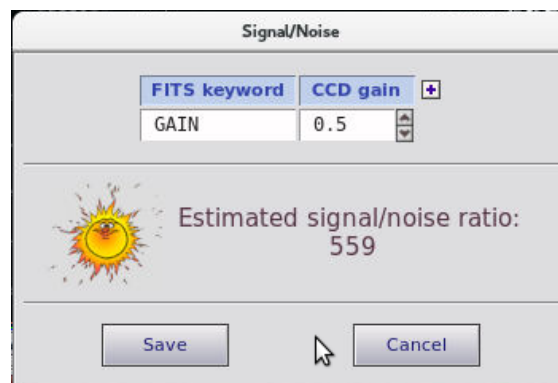


6.2 Estimating signal-to-noise ratio

1. Select an area with mouse from highest continuum values to lowest (don't be distracted by high fabry-perot peaks) and click 'Sun' icon on top of the spectrum viewer:



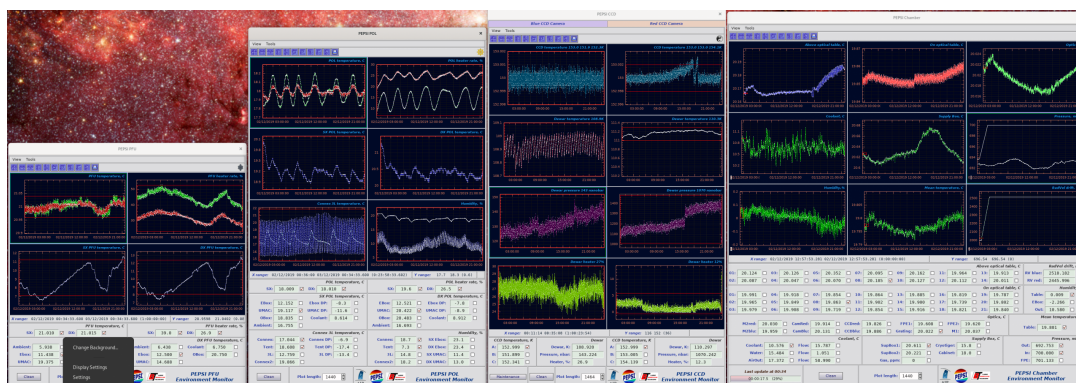
2. You get a pop-up window there the S/N estimate is given, save that information into fits list by clicking 'Save':





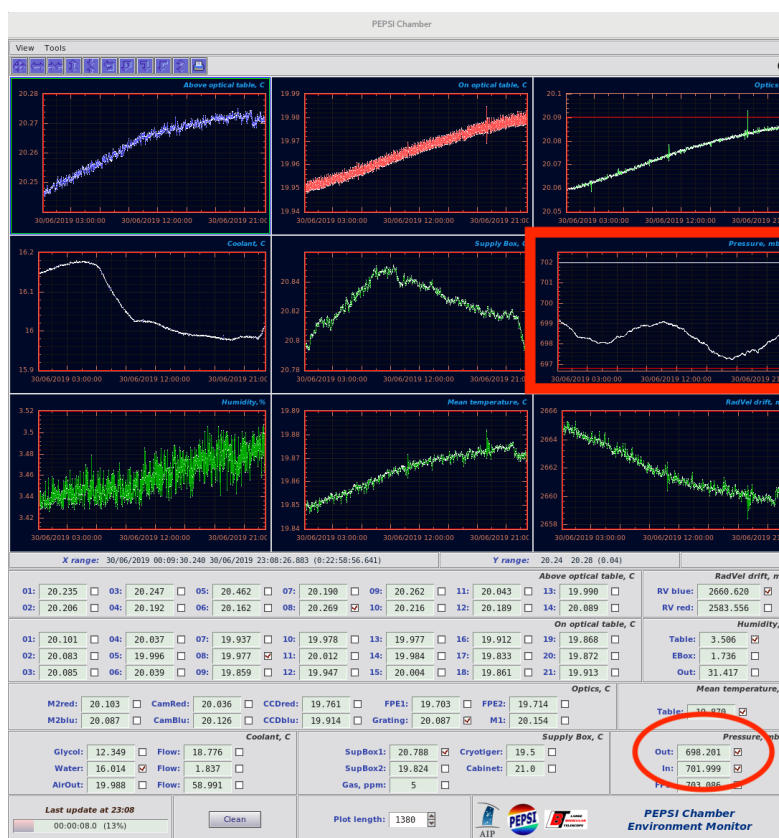
7 Telemetry

It is essential to **check the telemetry** from time to time:



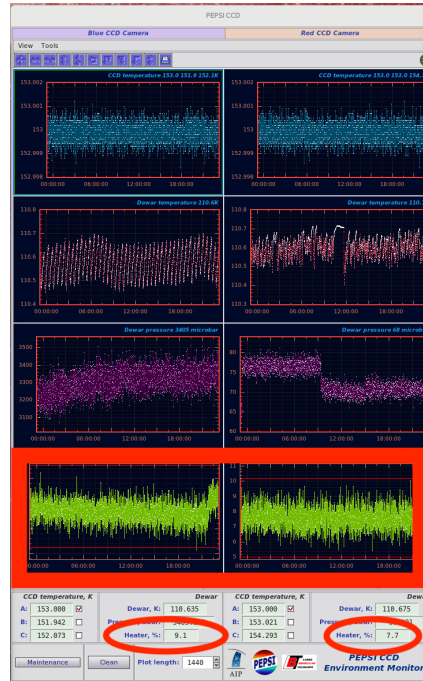
If something is wrong and you are not trained to fix the problem, contact a person who is!

The most important is the 'Pressure' in **PEPSI Chamber** window. If 'In' value has red background, and one sees that pressure curves follow each others, everything is not fine.



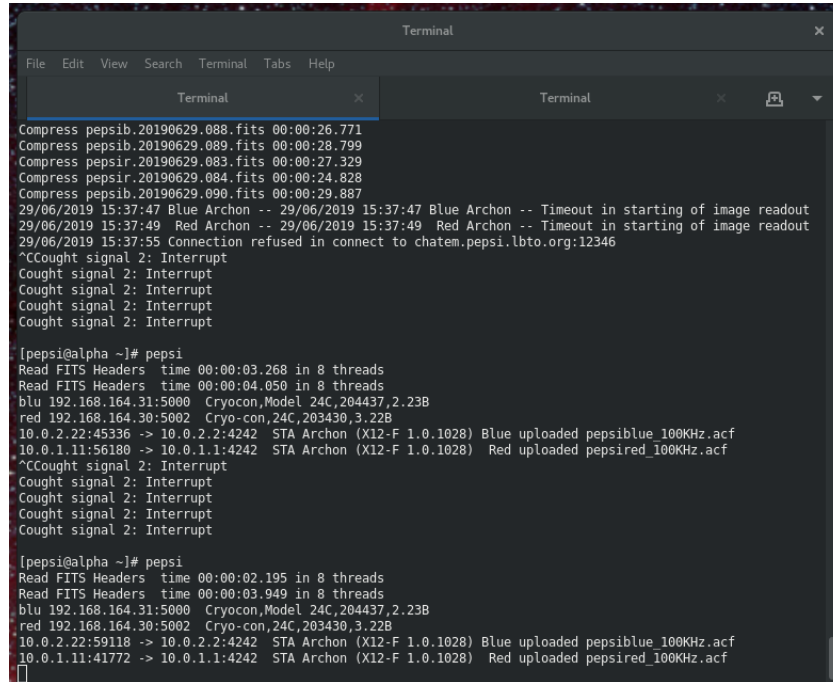


Other important measure is ‘Dewar heater‘ in PEPSI CCD window. If it approaches 0, the dewar pressure rises and pumping is needed.



8 Troubleshooting

Sometimes the software program freezes or even crashes (STA Archon time out). If that happens, find the following terminal



```

Terminal
File Edit View Search Terminal Tabs Help

Compress pepsib.20190629.088.fits 00:00:26.771
Compress pepsib.20190629.089.fits 00:00:28.799
Compress pepsir.20190629.083.fits 00:00:27.329
Compress pepsir.20190629.084.fits 00:00:24.828
Compress pepsib.20190629.090.fits 00:00:29.887
29/06/2019 15:37:47 Blue Archon -- 29/06/2019 15:37:47 Blue Archon -- Timeout in starting of image readout
29/06/2019 15:37:49 Red Archon -- 29/06/2019 15:37:49 Red Archon -- Timeout in starting of image readout
29/06/2019 15:37:55 Connection refused in connect to chatem.pepsi.lbto.org:12346
^CCought signal 2: Interrupt
Cought signal 2: Interrupt
Cought signal 2: Interrupt
Cought signal 2: Interrupt
Cought signal 2: Interrupt

[pepsi@alpha ~]# pepsi
Read FITS Headers time 00:00:03.268 in 8 threads
Read FITS Headers time 00:00:04.050 in 8 threads
blu 192.168.164.31:5000 Cryocon,Model 24C,204437,2.23B
red 192.168.164.30:5002 Cryo-con,24C,203430,3.228
10.0.2.22:45336 -> 10.0.2.2:4242 STA Archon (X12-F 1.0.1028) Blue uploaded pepsibblue_100KHz.acf
10.0.1.11:56180 -> 10.0.1.1:4242 STA Archon (X12-F 1.0.1028) Red uploaded pepsired_100KHz.acf
^CCought signal 2: Interrupt
Cought signal 2: Interrupt
Cought signal 2: Interrupt
Cought signal 2: Interrupt
Cought signal 2: Interrupt

[pepsi@alpha ~]# pepsi
Read FITS Headers time 00:00:02.195 in 8 threads
Read FITS Headers time 00:00:03.949 in 8 threads
blu 192.168.164.31:5000 Cryocon,Model 24C,204437,2.23B
red 192.168.164.30:5002 Cryo-con,24C,203430,3.228
10.0.2.22:59118 -> 10.0.2.2:4242 STA Archon (X12-F 1.0.1028) Blue uploaded pepsibblue_100KHz.acf
10.0.1.11:41772 -> 10.0.1.1:4242 STA Archon (X12-F 1.0.1028) Red uploaded pepsired_100KHz.acf

```

and type Ctrl+c and start all over again.

If terminal gives ‘Lost connection with Camera’, one can go to ‘PEPSI Control Unit’ Maintenance, but in order to do that, **you should know what you are doing.**